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Jamming Transition in Quasi-2D Self-Assembled Nanoparticle Monolayers

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We experimentally probe the structure and interparticle dynamics of iron oxide nanoparticle thin films self-assembled at the liquid-air interface. Upon deposition on a water surface in a Langmuir-Blodgett trough and subsequent lateral compression, iron oxide nanocrystals coated in oleic acid ligands self-assemble into a relatively uniform quasi-2D monolayer. We verified this film structure by s-ray diffraction in grazing-incidence geometry (GIXD). Utilizing x-ray photon correlation spectroscopy (XPCS) at beamline 8-ID-I of the Advanced Photon Source at Argonne National Laboratory, we have measured the characteristic timescale of in-plane interparticle dynamics. The degree of jamming in the system has been quantified by fitting a stretched exponential model to the autocorrelation functions produced by XPCS measurements. A jamming exponent of 1.5 has been calculated, a value that has previously only been observed in 3D aging soft matter systems. Since the accepted explanation for this exponent is strongly correlated with the number of degrees of freedom [1], this result was unexpected given the reduced dimensionality of our system. Additionally, the q-dependence of the interparticle timescale in the film is supportive of an anomalous diffusion regime, $\langle x \rangle^2 \propto t^n$, with $n > 1$. I will present these results and their implications with regard to thin film self-assembly, structure, and rearrangement.

[1] Bouchaud, J.-P., & Pitard, E. (2001). Anomalous dynamical light scattering in soft glassy gels. *The European Physical Journal E*, 6, 231–236.